Tools for Scientific Research and Advanced Prototypes

The tradition of fully integrating engineering expertise into scientific pursuit originates with E. O. Lawrence's team-science approach. As a national laboratory, Livermore is responsible for developing large-scale tools for mission-directed scientific research, such as the National Ignition Facility, and prototypes of systems for sponsors. Ranging from microscale to monumental scale—and frequently demanding ultraprecision and very-high-speed diagnostics—Livermore's prototypes meet important national needs and help push the frontiers of science and technology.

Keck Mirror Coating and Virtual Guide Star

Two projects in 2001 involving Livermore scientists and engineers are dramatically improving the performance of telescopes at the Keck Observatory in Hawaii and elsewhere. In one effort, a new ultrathin silver coating was installed on a 22-inch mirror for use at the Keck Observatory and then on mirrors in several other major telescopes. Patented by two Livermore researchers, the revolutionary technology was developed to protect the thousands of mirrors for flashlamps in the National Ignition Facility.

Livermore's ultrathin silver coatings have higher reflectivity and are far more durable than previously used silver coatings. The higher reflectivity means that large telescopes, which typically reflect the collected light off five or six mirrors, may have up to a 35-percent increase in light-collection efficiency. Samples of the ultrathin silver coating will also be taken to the International Space Station in 2002 and subjected to long-term tests to determine the coating's suitability for Hubble telescope mirrors and other space-based applications.

In a second effort, Livermore researchers and collaborators at the Keck Observatory created for the first time a "virtual" star over Hawaii in December 2001. The star was formed by using a 20-watt dye laser to illuminate a diffuse layer of sodium atoms about 60 miles above the Earth's surface. The sodium atoms produce a very small source of light, which can then be used to measure and correct for the distortions in the atmosphere that cause stars to twinkle.

The real-time control system to correct for the distortions, known as adaptive optics, had previously been developed by Laboratory researchers and installed on the Keck II telescope. With adaptive optics, the telescope's infrared images have four times better resolution than the Hubble Space Telescope. However, the system could be used for only about 1 percent of the sky because it required a sufficiently bright "guide star" near the faint object being studied. Now astronomers can study objects anywhere in the sky by creating a nearby virtual guide star where they need one.

Photo: John McDonald/Canada-France-Hawaii Telescope Corp.

1950s

Significant research facilities constructed in the 1950s included the Livermore Pool-Type Reactor (LPTR) and the 90-inch cyclotron, used until 1971 to gather large amounts of nuclear physics data. Until 1980, the LPTR supported a broad range of projects, from fundamental physics to studies of radiation damage.

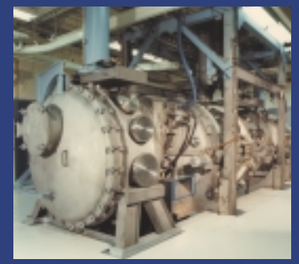
1960s

Two prototype versions of the Pluto ramjet nuclear reactor were designed at Livermore and then built and successfully operated at the Nevada Test Site. Reactor testing required the development of novel remote-handling technologies as well as systems capable of ramming about a ton of heated air through the reactor each second.

1970s

The Laboratory made significant strides in magnetic fusion research through the design, construction, and use of successively larger facilities. The Tandem Mirror Experiment in the 1970s demonstrated markedly improved plasma confinement. It led to design and construction of the Mirror Fusion Test Facility, which was shut down in 1982.

1980s



Livermore's progress in large-scale engineering development and demonstration of atomic vapor laser isotope separation (AVLIS) for uranium enrichment led DOE in 1985 to select the technology for further development. Large-scale laser programs such as AVLIS and the Nova laser brought greater industrial involvement with advanced lasers.

1990s

B-Factory construction at the Stanford Linear Accelerator Center was an international collaborative effort. Livermore's involvement has ranged from particle physics to engineering design and precision machining. The Laboratory contributed to three of the seven systems for the B-Factory's detector. Researchers are now engaged in data analysis.